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## IN MODERN THOUGHT

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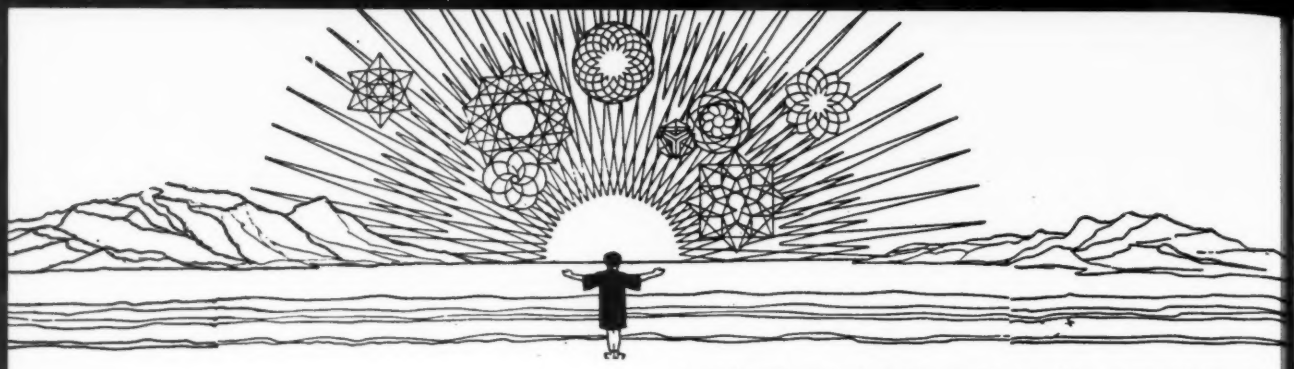

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# MAIN CURRENTS
## IN MODERN THOUGHT

**A cooperative journal to promote the free association of those working toward the integration of all knowledge through the study of the whole of things, Nature, Man, and Society, assuming the universe to be one, dependable, intelligible, harmonious.**

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The wood statue of St. James the Less (13th cent., Rhenish) is shown through the courtesy of the Metropolitan Museum of Art, Fletcher Fund, 1928.

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# MAN'S UNIQUE DISTINCTION*

Edmund W. Sinnott

Yale University

## Creative Imagination as Man's Highest Resource

IT is a significant fact, I think, that we are less concerned today about the nature of God than were our grandfathers but much more concerned about the nature of man. This does not necessarily mean that theology is less important than anthropology and psychology but rather that it seems so difficult of approach by the rational methods now commonly employed for other problems that we have been persuaded to turn our attention to matters more hopeful of solution. A further reason is that human nature poses the most important of *practical* questions, for knowledge of how to control matter and energy, with all this means of promise and peril for our race, will be of no avail unless we also gain an understanding of the remarkable organism in whose hands lies the responsibility for using this knowledge wisely. It is no wonder, therefore, that man as a subject for research and discussion today occupies the center of the stage as he never did before. We need no poet to convince us now that the proper study of mankind is *man*.

A century ago the nature of man presented no particular problems. He had been created out of the dust of the ground but in the image of God. He was a little lower than the angels and an immortal soul was his to save or lose. For most thoughtful people, however, this concept was radically changed by the shattering impact of the doctrine of evolution. Man was no longer unique in origin, said Darwin, but had come up, as had the beasts, over a long evolutionary pathway from the simplest forms of life. This was startling enough to nineteenth-century complacency but the discoveries of physiology, genetics, biochemistry and psychology humbled man still further. The conviction now began to grow in many minds that man was not only brother to the lower forms of life but that neither he nor they were in essence more than exquisitely complex mechanisms, material systems built of specific substances and the seats of controlled exchanges of energy. This mechanistic philosophy was by no means new but never before had it been supported by such a wealth of scientific evidence. The pre-Darwinian conception of man had thus been turned quite upside down. He seemed to many a creature without dignity, freedom or responsibility, possessing no real significance in the universe and destined at last for nothing but obliteration.

In more recent years, however, there has been a growing dissatisfaction with both the traditional and the purely mechanistic views of man's nature. His origin was admittedly by a process more involved than the one described in the first chapter of Genesis, which gave no hint of his close relation to the rest of nature. On the other hand, a recognition of his rational, aesthetic and spiritual qualities and especially of the immense potentialities that are his made the concept of him as a mere mechanism unsatisfying. Instead of regarding him as an insignificant creature in the universe, humanism now elevates man to a supreme position as the crown and glory of the creative processes of nature and with a future more exalted still. Not everyone adopts this roseate view of man, however, for neo-orthodoxy still looks upon him as a being loaded with the guilt of original sin and needing the grace of God for his salvation. Half ape, half angel, he remains, indeed, the "glory, jest and riddle of the world."

It is impossible today to reach general agreement about man's nature any more than about the nature of God. It should be possible, however, to make a beginning at this task by seeking dispassionately for whatever distinction there may be that sets man off from the rest of animate nature; to determine

*Colloquium address, delivered at the May, 1958 meeting of the American Unitarian Association, in the First Church, Boston, Mass.

in what ways, if any, he may be regarded as unique. I should like to mention here a number of such possible distinctions. These are less easy to discover than they might seem to be, for although man is greatly different from the lower forms of life in many ways, most of these differences when examined closely are found to be only in degree.

BIOLOGICALLY, man is certainly an animal. Like any other creature he occupies a particular niche in the taxonomic system. He is species *sapiens* of the genus *Homo* and among the Primates. His body is constructed on the typical mammalian plan and is closely similar to those of the higher apes. Physiologically he is very similar to them also, and many of his diseases are the same as theirs. If his creation was a unique event it is very strange, as Huxley once remarked, that there should be no sign of this in his bodily traits. Only the most obtuse of fundamentalists today would deny that man's physical ancestry is among the beasts.

If this be admitted, we must ask what distinguishes the species we call man from others lower in the scale. Is he in essence nothing *but* an animal or does he have some special attribute that justifies his ancient claim to at least a spark of something that may be called divine? A knowledge of man's evolutionary history here helps us little. Today there is no difficulty in distinguishing human beings from the other primates, but in the not distant past there were at least two species of *Homo,* our own *sapiens* and the much more primitive *neanderthalensis.* Was the latter human? And what of our ancestors still earlier in the evolutionary series? Their brains were certainly larger than those of any apes we know today but compared to modern man they were primitive indeed. If we should find one of them now—if the "abominable snowman" should by some strange chance turn out to be a creature of this sort—what would we think of him? Would we try to save his soul or would we put him in a zoo? Somewhere along the evolutionary ladder of man's slow ascent there must have been a point where a subhuman animal became a man, but had we been there to observe the process we should have had great difficulty in determining just where this was. If we accept the theory of man's evolutionary origin, it is hard to determine just where he became qualitatively different from his animal ancestors.

For a radical change to be interjected somewhere in this slow, continuous process of ascent would be almost as miraculous as would be direct creation. To be sure, the universe is full of critical points where radical alterations take place. Genetic mutations, often of considerable size, may also suddenly appear, and some think man may thus have come to being. Such suggestions, I believe, lack realism. As good evolutionists we are almost forced to the conclusion that man arose by gradual and imperceptible steps and that to find the exact point where an animal became a human being would have been as impossible as to determine the exact moment when a child becomes a man. In the great chain of life, as Joseph Wood Krutch has called it, we are brothers to everything that lives, and fashioned from the same protoplasmic stuff.

In seeking man's distinctive quality we should therefore look not for something radically new but for the high development of something potentially present among simpler organisms. A quantitative change, if carried far enough, often introduces really qualitative differences. We should remember that the evolutionary process, continuous as it indeed has been, formed creatures as radically different as worms, insects, fishes and birds. Man's advances over lower forms in most of his qualities are so very great that he has become actually a different sort of being. This we can freely admit without assuming a difference in his origin and theirs. Our search must be for some quality that arose, however slowly, in his long progression which may be called distinctively human.

THE traits in which man has achieved the most pronounced advance over his non-human ancestors are evidently psychical rather than physical ones. Our bodies are excellent mechanisms but we should never have gained ascendency over nature by their means alone. Mind, intellect, reason—these are the attributes that have enabled man to manipulate nature and thus rule the world. For many, this is his unique distinction, the quality that makes him really human. Certainly it is his most conspicuous trait. Man is the rational animal *par excellence.* Mind has its roots, however, far back in evolutionary history. We need not enter here upon the long debate as to whether animals can reason. Certainly in many of the higher mammals one finds examples of behavior that are hard to explain except as the result of at least a primitive sort of rationality. Something strictly comparable to the human mind—if psychologists will allow us to use this term!—is evidently present in the more highly developed vertebrates. Mental processes, in the broadest sense of the word, can hardly be thought of as peculiar to our species.

Although intelligence itself may not be confined to man, say many, it has made possible other traits that often have been looked upon as his unique distinction. Tool-using is one of these. When an archaeologist finds artifacts, even the simplest sort of chipped stone implements suited for some particular task, he is convinced that these were made by an intelligent and man-like being. The ability to manipulate material things led to the bow and the wheel and thence to the fantastic development of technology which so distinguishes modern civilization. Man is not only *Homo sapiens* but *Homo faber.* But this distinction is hardly unique for man, since cases are known where sticks or other objects have been used by various higher animals to accomplish their ends. I, for one, would

hesitate to admit that an ape which used a stone to crack a leg bone for its marrow had by that act become a human being.

The use of articulate speech is another outgrowth of intelligence that is often thought of as uniquely human. It is the commonest means for the communication of ideas from one person to another and is ultimately the process by which experience has been accumulated and man's rapid cultural advance during the past few millenia made possible. But here, again, the roots of this distinction lie far back. Many animals, especially gregarious ones, communicate with one another by various means. In the higher forms this is accomplished by calls of many kinds. Apes can make a considerable number of different sounds expressive of their desires and intelligent dogs have been known to learn what was meant by more than a hundred words. Speech, and ultimately a spoken and written language, are certainly among man's major distinctions and are closely involved with his processes of thought, but whether they are unique in him may well be doubted.

These distinctions basically involve the use of the intelligence and one may object that intelligence, far from being a strictly human trait, is only a mechanical process, after all. A complex electronic calculator, presented with a mass of data, can classify, relate, remember and predict. There is reason to believe that these paragons of technology can do almost everything —the reservation is important—that the human mind can do, and far more rapidly and accurately. We do not, because of this, regard them as human. Superhuman mechanisms they perhaps may be, but surely not men.

Man, it may be argued further, is distinguished not so much by his intellectual qualities as by still higher ones that grow from these—his emotions, his moral and aesthetic values and those attributes we commonly call spiritual. It is the poet and the artist and the saint and the seer in a man that lift him up above the brute creation, and even above the mere thinker, and make him but a little lower than the angels.

Let us remember, however, that Charles Darwin wrote an illuminating book on the expression of the emotions in animals in which he presents a long array of instances where they display fear, love, hate, envy, jealousy, rage and other emotions that we associate primarily with man. Anyone who has watched an intelligent dog sympathetically can hardly doubt that the creature is swayed by feelings much like those we have ourselves. "Anthropomorphism," warns the psychologist. "What evidence have we that the animal actually feels these emotions as we do? We are simply attributing to him our own human sensibilities." Here, I think, we may be leaning over backwards to preserve objectivity at the sacrifice of common sense. We should remember Lorenz's caution that mechanomorphism is as dangerous as anthropomorphism. What evidence have we that our friends feel the same emotions that we do except that they act as though they did? Should we not judge a dog's behavior in the same way?

But emotion, I think we will agree, is not a trait that should be looked on as distinctively human. It is not mere emotions but the loftier ones that we regard as uniquely man's. Especially should we stress his dedication to high values, to such intangible but very real things as beauty, goodness, truth and the fruits of the spirit. Where, one may ask, are such goals pursued by any other creature than ourselves?

Such an argument is a strong one. Value judgements of this sort, we like to think, denote a god-like quality in man and are something peculiarly his own. But let us not forget that the beasts have values, too. Who can doubt that there are many things they desire or dislike? The rudiments of value-seeking lie in the tendencies displayed by every organism to conform, in its development and behavior, to norms established in its living system. Even the high aesthetic and moral goals so typical of man at what he always has regarded as his best, are not without their beginnings at lower levels.

In his *Descent of Man,* Darwin has discussed the preference of female animals for particular colors, forms and sounds and on this based his theory of sexual selection. Who can doubt that the female peacock is impressed by the magnificent plumage of her suitor? Darwin cites the curious habit of the bower birds, which decorate their playing places with bright objects. There are many instances of this primitive sort of aesthetic sense. Were not most mammals colorblind, they would probably display the same behavior. To appreciate beauty in its many forms is surely a great gift of man. How empty our lives would be without it! He would be rash, however, who would say that this quality did not show at least its first stirrings below the human level.

THE moral sense has often been regarded as distinctively human. Where among lower forms, it may be asked, is there ever a question of what *ought* to be done? What beast has a conscience or a sense of moral obligation? But here, again, it is difficult to draw a sharp line. Maternal love among the higher animals is familiar to everyone. Whether it has a hormonal basis is beside the point. Perhaps it does in man! Love is love, whatever its physiological correlates may be. Kropotkin, Allee, Montagu and others have emphasized the selective value of cooperation in nature, as contrasted with the earlier idea that competition is the invariable basis for evolution. There are innumerable instances, particularly among gregarious animals, of behavior helpful to the group though it may be hurtful to the individual displaying it. The attachment of an animal to a particular person may far transcend its own self-interest. Dogs have often died for their masters. This may not be a rational and de-

liberate kind of selflessness, but the same is true of many acts of human devotion. Certainly the germs, at least, of altruism go far lower in the scale than man.

As to the origin of higher spiritual values, little can be said. Here we enter the domain of philosophy and religion. Darwin again, however, has a suggestion to make. "The feeling of religious devotion," says he, "consists of love, complete submission to an exalted and mysterious superior, a strong sense of dependence, fear, reverence, gratitude, hope for the future and perhaps other elements. . . . We see some distant approach to this state of mind in the deep love of a dog for its master, associated with complete submission, some fear, and perhaps other feelings." It has been suggested that a dog looks on his master as a god.

These high values, one must admit, are not widespread among the lower animals but enough of their rudiments are there to preclude man's unique claim to them. Among the ape-men their beginnings doubtless appeared in forms we now would not admit were human.

One other distinction, important in the history of our problem but receiving little emphasis today, is the possession by man of a supreme treasure, his soul. This, in the sense in which the word is commonly used, is what really makes him man. The church of Rome is willing to accept, though in some quarters rather doubtfully, an evolutionary origin for man's body, but his soul it regards as the result of God's special creative act. Here, as with the mind, we are faced with the difficult problem of determining just where, in man's evolutionary ascent—or indeed in the development of an infant from a fertilized egg—the soul enters the body. In recent years the soul has largely been written off in psychology and anthropology and, save in religious orthodoxy, has been limited to a figurative and poetic status. Latterly, however, it has begun to gain some scientific respectability, if only under the terms *self* and *personality*. We recognize that a human being, psychologically, is not simply a stream of conscious states but that there is in him, so to speak, a homeostatic core of being which integrates his reactions to the throng of stimuli he receives and serves as a continuing center for his life. To quote from an earlier publication: "This individual self, this personality centered in living stuff, persistent amid the flux of time and circumstance, aware of itself and of the universe around it, able through memory to look back and through imagination to foresee and mold the future—it is this self, the essence of a man, that offers a foundation for the concept of the soul. By many the soul is looked on as a mere superstition and without importance, one of the myths that man in his enlightenment should now discard. And yet this persistent tendency of life to round itself up into unique individuals from which the fine flower of human personality has come indicates that these may be more permanent and significant than ephemeral pieces of protoplasmic machinery; that they may have meaning in the universe."*

This again is a philosophical problem but it touches closely, though from a different direction, the matter we have been discussing here. The possession of a soul, if it could be established, would indeed be a notable human attribute. To accept it, however, might require us to postulate at least a proto-soul in every living thing.

If none of the qualities I have mentioned are so characteristic of man that they may be regarded as his unique distinction, is there *anything* that can be considered such? I believe there is, and shall present some evidence in support of this contention. The quality I propose is a simple one, but different from the others in some important particulars. It is *imagination*. This may seem relatively inconsequential, perhaps, compared with some that have here been discussed, but it involves a different aspect of man's nature—his creativeness. The subject of creativity is receiving more attention nowadays than it ever has before. This comes, I believe, from the growing realization that human progress, not only in technology but in every aspect of our culture, involves the birth of new ideas. These may be expressed in inventions, in new scientific concepts, in fresh insights in philosophy, poetry, painting, literature and music or in any other activity of man. They involve the *creation* of something. This creative process is a mental one. A new idea in any field is produced in the mind of a single individual, though its origin may be greatly stimulated by others and by outward circumstances. Just what this process is and why it is peculiar to man will require a brief excursion into some biological facts and their implications.

FIRST, life itself may be regarded as at bottom a creative process. An organism has three essential qualities, I believe: (1) It reproduces itself, thus assuring the continuity of its type; (2) It regulates its development and activities in such a way that it maintains itself as an organized system. (3) It is not static and unalterable but shows a persistent tendency to change, thus making evolution possible. This third quality is what gives to life its creativeness. Inanimate matter is conservative. Since the beginning of the universe it has continued to produce the same sorts of things—electrons, atoms, stars and galaxies. How in the midst of this sameness life began we do not know, but only when matter becomes endowed with the properties of life does something really new begin to happen. Evolution is a creative process and from the beginning has been bringing forth biological novelties, things never seen before in the lifeless world. It should be studied not simply as a *history* of life but as a continuing process, promising almost limitless creative changes in days to come.

But human creativeness is not of this slow biologi-

* E. W. Sinnott. *The Biology of the Spirit*, p. 158.

cal sort. In it we are concerned not with the genesis of new organisms but of new ideas; not with organic evolution but with creative imagination. Surely, one may say, these are very different things since one is in the realm of the physical and the other in that of the psychical. I should like to suggest that these two realms may be much closer to each other than is commonly believed. There is a similarity between them which suggests that they are really two manifestations of the same phenomenon—life itself.

Elsewhere I have endeavored in some detail to develop the argument that mind has come from the self-regulatory quality of living stuff and that the simplest sort of psychological processes, the most primitive mental acts, the basis of all ideas and even of abstract thought, are *purposes*. The argument on which this conclusion rests is simple. A fertilized egg is a living system in which a specific group of genes are so related that they guide the orderly development of the individual produced from the egg. The characteristics of the individual are fore-shadowed in the egg from which it comes and embryonic development is an unfolding of these specific potentialities. This unfolding is not a simple linear one, however, for if development is blocked or disturbed, the organism shows a strong tendency to get back on the right track, to restore missing parts and thus to regulate itself in conformity to a norm set up in the egg and throughout its living stuff. This may be reached along many different paths and not by any one alone, a fact that Driesch termed *equifinality*. It is the presence of this norm which is the essential fact in development and gives unity to the whole process. Physiological activities are equally self-regulatory.

The very fact of regulation implies the existence of a norm, of something to regulate *to*. Agar, E. S. Russell and others have suggested that norms are operative not only in bodily development and function but also in behavior, and that instinct is regulated behavior, directed to the accomplishment of ends which have their basis in biology. For the performance of any instinctive act the conditions are almost always a little different but the act is still performed. Behavior conforms to a norm or goal set up in the living stuff of the nervous system much as development conforms to one set up in the other cells of the body. Such a behavioral norm, it can well be argued, is a primitive sort of *purpose*. *Conscious* purpose is simply the subjective experience of the operation of such a norm and has emerged in the higher animals from the unconscious purposiveness of the lower ones. From purpose, the most primitive psychical phenomenon and leading directly to bodily action, there came desire, value judgements and other purely mental acts, and finally abstract thought.

THIS conception of mind as at base a regulatory biological activity and essentially teleological thus sees the germinal beginnings of mind as coextensive with life, since all life is self-regulatory. It regards life itself as teleological. This word is so inflammatory to many biologists, who have been brought up to regard all forms of teleology as anathema, that one hardly dares to use it. The sort of teleology here discussed is philosophically quite innocuous, however, for self-regulation in machines is familiar enough today and biological self-regulation can be interpreted in as mechanical terms as one wishes. But the living mechanism is far more complex than any product of technology and may involve physical principles as yet undiscovered. From our favorable position inside such a system we can, so to speak, observe self-regulation from within and thus study human purposiveness more directly than by objective study alone. It is significant that introspection is beginning to come back into good repute in psychology with the recognition that man is inside his most important specimen and can learn much thereby.

The philosophical implications of all this are important but do not concern us here. My purpose in discussing these matters is to make clear what is involved in the creative process as we see it in man. In bodily evolution, novelties arise by means of genetic change. A further enrichment of these novelties results from changes in the environment, for we must recognize that what a given genetic constitution governs is not a specific trait but a specific reaction to a specific environment. The norms to which regulation conforms may thus be quite different in different environments. There are innumerable instances of this in genetics. Wing venation in *Drosophila* and flower color in some plants are very different if the individual develops in one temperature from what they are under another. One mutation may thus produce a large number of new visible expressions if the environment is varied. Traits of behavior are particularly susceptible to these external factors. An active animal is continually exposed to a variety of environmental stimuli. Its inner norms also change with internal conditions—whether it is hungry or well fed, or where it is in its breeding cycle. Its psychological life is a continual regulation of its behavior as outer and inner conditions change, and may thus assume a considerable degree of complexity.

In von Frisch's fascinating story of the language of the bees, for example, the author shows how a single bee, by communicating information to his colleagues, may modify their behavior. If he has discovered a rich supply of nectar of a particular kind he returns to the hive. The other bees can tell by odor the flowers from which he has come, and by a specific series of motions he also informs them not only in what direction the treasure lies but how far away it is. The bees rush out to find it and soon begin to bring the nectar home. The behavior pattern—the goal—of each has been set up in its nervous system for that day by a stimulus from the discoverer bee. Tomorrow the goal may be a different one and the

next day different still. Above these temporary goals is the transcendent one of finding nectar and bringing it back to be stored within the comb. Below them, in turn, are those briefer ones which draw the bee from flower to flower in response to its sensations of smell and sight. In each bee there is an end, enduring or temporary, to which the pattern of its behavior conforms. This hierarchy of goals is subject to continual modification by inner and outer factors. As a result, the psychical life, so to speak, of this little animal is far from being a fixed and stereotyped one but shows a considerable degree of diversity.

Among higher animals, goals and purposes become far more numerous and complex. Many of them conflict and are incompatible, and therefore cannot result in physical behavior. Some become desires or primitive mental acts. Memory and learning have emerged to important positions. All this increases the variety of the animal's psychical life. A hungry fox trotting through the woods comes on the trail of a rabbit. His continuing goal, to satisfy his hunger, now is sharpened to the more specific one of catching this particular rabbit. His behavior is largely instinctive, but if he is a wise fox experience has improved his skill in hunting. His memories of the thicket where a hound once almost seized him or of the bar-way where a hunter shot at him or of the point on the path where a trap once caught his mate all modify the way in which he seeks to realize the end of catching the rabbit and having him for dinner. The fox probably has no stream of conscious ideas in these matters, but his memory of former experiences modifies his behavior and enriches and complicates its pattern. His major goal of satisfying his hunger may change as the season comes to seek a mate or to hunt game for his cubs instead of for himself, and these changes further enlarge the variety of his goal-seeking.

ALL this, however, is at last really no more than an upward extension—far upward, to be sure—of the self-regulatory character which underlies physical and psychical development. It still involves a specific genetic constitution responding to specific environments. Without more than this, we may be sure, man would never have advanced beyond the level of a clever beast. But in the primate stock, when man arose, something really new occurred, something that bore the promise of abundant creativeness and carried with it the possibility of man's spectacular advance. This was the birth of his imagination. Whether it came because of the wide variety of choices for behavior now open before this promising animal and the host of purposes seeking fulfilment, or whether it was simply a natural development in the increasing complexity of his mental life, we do not know. What happened was that the man-ape now began to go beyond the ancient pattern and entered a new realm. Instead of simply making his bodily or mental acts conform to norms within him, determined by his genetic constitution and modified by environment and conditioning, he was able for the first time to recognize *possibilities* beyond the range of previous experience or the stimulus of a particular present environment. He could get outside of the immediate situation, to to speak, and picture something that *was not* but *might be*. Toward this, as a new goal, his acts could be directed. His development had reached a point where, in a sense, he could set up such a new goal without the necessity of a genetic mutation or an environment change to do it for him. This was a true *creative* act. What the biological or physiological or psychological basis of it was or is we do not know, but here there seems to have occurred a true novelty in the long course of human evolution. As in other psychical activities, the beginnings of imagination may perhaps be found in the lower animals, but they must surely be rare and weak, at best. A dog, doing a trick to get a tid-bit, does not, I think, imagine how good it will taste. He simply wants it and does all he can to get it. A mother bird, defending her young, does not imagine what their loss would be but rather bends her every energy to reach the goal of safety for them. In man, however, some of his most acute emotions, both of pleasure and pain, come not from actual experiences but from imagined ones.

Whenever behavior rises above the more mechanical pursuit of goals and stops to consider the various alternatives or possibilities for action which confront an individual, imagination is born. Just where this first occurred, a psychologist would have trouble in determining. The more creative acts of the imagination, however, must at first have been fumbling and simple ones involved with man's daily life. Perhaps in playing with a heavy stick and injuring his comrade, the possibility came into his mind that such a tool might be useful against a wild beast or an enemy, and thus the club began. Doubtless many of these first steps were the result of accident, but slowly and laboriously imagination went to work. Every advance in the pattern of culture must first have been born in someone's imagination, doubtless helped by chance and circumstance but nevertheless in some small measure a creative act.

The progress of man's culture was marked by the accumulation of these creative events, some of them rare and of particular importance, like the discovery of the bow and the wheel and the practice of agriculture, but others of every-day occurrence. As society developed, his outer environment became much more complex. The inner environment of his mind was also vastly richer. His memory was far more extensive than that of the beasts, so that by it and with the invention of speech and written symbols he was able to use the accumulated experience of the past. Many of his goals were now fulfilled not by bodily actions but by mental ones. To gain knowledge became one of his major ends. There began to grow in his mind the

ability to think. By seeking the relationship between facts, he learned to recognize uniformities and to relate particulars to them, and thus to reason and to deal in abstractions. This, it should be noted, depends on the use of the imagination and cannot occur until the imagination has developed, for logical thought involves the recognition of alternatives and possibilities.

Self-consciousness, one's ability to stand outside himself, to recognize his own existence and to take an objective view of it, has often been regarded as a peculiarly human quality. But is not this also an example of the exercise of his imagination? Thus to picture himself as a dual individual, as observer and observed, is surely an imaginative act. If self-consciousness *is* unique for man, it is a result of that quality which I have suggested as most distinctive of him.

Man's rapid rise came fom this imaginative and creative power that made him man. It showed itself in many ways other than mere inventiveness, conspicuous and important though this was. The development of the sciences depended upon the creative imagination, for it is recognized that science, at its highest levels, involves much more than the gathering and classifying of knowledge. Imagination establishes for it new goals. Its supreme expression is in the formulation of unifying ideas and concepts that bring meaning to a mass of facts; a recognition of the order that underlies them. This bringing of order out of chaos, in a corner of the universe that at first seemed "without form and void," is a truly creative process.

From the beginning, man's concern with the beautiful gave particular opportunity for the expression of his creativeness in works of art, primitive at the start but even in simple cultures reaching high development. In the work of the poet, the artist and the composer there is manifest the power of his imagination to create new goals, new patterns, new ideals that men had never known before. "Beauty," said Coleridge, "is unity in variety," and the artist, like the scientist, seeks to find and interpret the order that is present in nature. In the arts this order is more subtle and difficult to discover, less sure to be recognized, than in the sciences but it is there, and the measure of greatness in a work of art is the degree to which the artist has been successful in discovering and expressing it. In ethics and philosophy and indeed in all scholarly explorations by man's mind there is the same search for order, the same attempt to find in the variety of his experiences those unifying concepts which will organize them into a satisfying pattern.

WHAT is the nature and origin of such creative acts? Much thought is now being given to this problem. In many cases creation is a rational process, carried out deliberately and with purpose, the hidden order being discovered by direct attack. Thus much creative work in science and the arts has been accomplished. Intelligence must always guide and direct the creative process anywhere. Often, however, this is not enough, and the worker, after laboring long and earnestly, his mind filled with the facts and ideas which he has been trying to set in order, is forced for a time to give up the effort. He may relax and think of something quite different, or of nothing at all; or he may go to walk or to sleep. Before long the answer he has been seeking, in the form of a scientific solution or the outline of a painting or the composition, at least in part, of a poem or a piece of music, may come sauntering into his mind while he is not thinking of it at all. The literature of the subject is full of instances of this. Notable among them is Poincaré's elucidation of the Fuchsian functions, upon which he had been fruitlessly working for a long time. He finally decided to take a holiday in Switzerland, and just as he was starting out, the solution of the problem flashed into his mind. A. E. Housman tells of how often a quatrain or more of verse would come to him quite unexpectedly and while he was thinking of something else. Many similar instances have been recorded.

In such cases the creative act is evidently accomplished at a level far below that of focal consciousness. What seems to be happening here is that in the unconscious mind new combinations of ideas are continually being made and facts fitted together until, unhindered by the blocks so often present in conscious thought, an orderly and logical arrangement is achieved which unifies scattered facts or presents an aesthetically satisfying pattern. It then emerges into consciousness, unheralded and unexplained, as an insight or an inspiration. Such unconscious creativity is operative only at the human level, where the psychical apparatus has reached a degree of complexity that makes it possible. It does not come of itself but only after the way has been prepared for it by long and hard thinking which fills the mind with ideas; the raw data, so to speak, that unconscious creativeness can then proceed to put together.

The fact that so much creativity operates in the unconscious and is not simply an aspect of man's rational thinking pushes the problem of its origin back into the biological foundations of the mind. This is important for our argument. The recognition of unity, order and meaning in a mass of experiences that seem at first to be unrelated, is really an organizing process. It suggests that creativeness may be another manifestation of the organizing capacity which, as we have seen, is characteristic of all life. When a scientist brings order out of a mass of facts and builds them into an organized system of ideas, is he not doing very much the same sort of thing that an animal or plant does when it draws in from its environment a purely random mass of food and builds it into the organized living system which is its body? In the process of development a living thing actually *creates* its own body out of formless stuff. It does this in conformity to a norm established in its genetic constitution. When a

scientist or artist performs an act of creative synthesis, however, he does something more; he conforms to a *new* norm that he himself establishes. Imagination of this sort we recognize as truly creative.

In the great majority of cases, of course, the creative element in imagination is much less pronounced. Merely to picture in the mind a situation not known in experience or held in memory, only in rare cases produces anything that is significant, but it is nevertheless a creative act. It is the frequency of such acts that makes the mental life of man so much richer and more interesting than that of even the most clever animal.

IF creative imagination is indeed man's unique distinction, this attribute, I think, may serve to lift him above the level of what many are inclined to think he is—a physical mechanism, vastly complex but still a mechanism. At least it introduces a new element into the concept of mechanism. Our wonderful modern electronic calculators show the possibilities, and the limitations, of any machine. They will take whatever data are put into them and by a process not unlike intelligence, make logical choices and draw logical conclusions. The quality they seem to lack entirely is imagination. They can analyze and simplify, classify and rearrange, but none of them has yet produced an original pattern, a creative synthesis. They follow rules with a speed and precision that is fantastic, but to compose a symphony or write a poem or produce a work of art seems to be quite beyond their competence. This particular distinction between man and mechanism, between the highest development of a biological system and of a purely physical one is, I believe, the deepest of all. To discover its nature and its origin is a major problem for the scientist and the humanist alike.

And finally, does not this concept of his nature help to restore to man the loss he suffered in his own esteem when he came to realize that his origin was not unique? It is as Creator that God is first described; not as the God of righteousness or wisdom or justice or love but as the Maker of heaven and earth. This is a primary attribute that men always have ascribed to what they regarded in the universe as Divine. If man alone among created things has reached a level where, though in minor measure, he can share in the creative process, does not this point to something godlike in him? Can he not think of himself, in this respect at least, as made in God's own image? This is perhaps to carry our contention farther than the evidence can justify, but it at least suggests an approach to the study of man's nature which may help to set him in his proper place as a not inconsequential figure in the universe.

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# DIMENSIONS OF THE HUMAN RELATIONSHIP

Clark Moustakas

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## The Unitive Ground in Human Society

### *The Human Potential*

I believe in the limitless potentials of human beings, in the value of humanness and human existence, in the necessity of personal relationship in all significant growth, and in the transpersonal life of individuals. The human organism is by its nature constructed to relate creatively, to participate in interhuman experience, and to be fully alive as a human being. Yet in spite of this potential, this inherent and natural state, there has been a turning away from the shared experience, from the transpersonal, from the creative, the fresh and naive, to the habitual, the conditioned, and the standard. In brief, most social situations involve reactive interactions between ghosts of people rather than creative relationships.

When I reflect a child's feelings in play therapy, I am reacting to his stimulation. When I sit with him in a communal sense, when we take each step together, I am creating with him for him and myself and all our relationships a new life, a new experience, a new feeling. I am relating, as one person to another person. I meet him and we are joined in a process of life. But when someone says something which I react to and balance off, then I act as if I had to state myself in order to put his idea in "proper perspective," to minimize his stand or to compete for status. I am reacting, participating as a reactor, an external act in response to an external event. I am not within human life being lived.

### *The Human Relationship*

AS I see it, the truly human relationship is something other than stimulus-response interaction. It is a meeting between persons, not for purposes of evaluating or directing or even understanding, but a whole relatedness of two persons in a spirit of unity. It is the bringing to a relationship all that there is in potential and in experience. This transpersonal sharing gives meaning to relationship. The support, the strength, the new vistas opened are all incidental to the participation in a life process. Anything but this wholeness fragments the person, treats him as an object, and makes for a reactive situation. In the human relationship nothing intervenes—no system of ideas, no foreknowledge, no aims, not even anticipations. It is a matter of being, of presence, of a life being lived, rather than a matter of individuals acting and being acted upon.

### *I and Thou*

BUBER calls this an I-thou relationship. Some passages from his *I and Thou* (1, 4-11) illustrate what I am trying to express:

"When *Thou* is spoken, the speaker has no thing for his object. For where there is a thing there is another thing. Every *It* is bounded by others; *It* exists only through being bounded by others. . . .

"If I face a human being as my *Thou,* and say the primary word *I-Thou* to him, he is not a thing among things, and does not consist of things.

"This human being is not *He* or *She,* bounded from every other *He* and *She,* a specific point in space and time within the net of the world; nor is he a nature able to be experienced and described, a loose bundle of named qualities. . . .

"Just as the melody is not made up of notes nor the verse of words nor the statue of lines, but they must be tugged and dragged till their unity has been scattered into these many pieces, so with the man to whom I say *Thou.* I can take out from him the color of his hair, or of his speech, of his goodness. I must continually do this. But each time I do it he ceases to be *Thou.* . . .

"The *Thou* meets me through grace — it is not found by seeking. But my speaking of the primary word to it is an act of my being, is indeed *the* act of my being.

"The *Thou* meets me. But I step into direct relation with it. Hence the relation means being chosen

and choosing, suffering and action in one; just as any action of the whole being, which means the suspension of all partial actions. . . .

"The primary word *I-Thou* can be spoken only with the whole being. Concentration and fusion into the whole being can never take place through my agency, nor can it ever take place without me. I become through my relation to the *Thou;* as I become *I,* I say *Thou.*

"All real living is meeting."

### *The Absence of Goals*

THE meeting of persons on a deeply fundamental level is the primary factor in human relationships. In such a meeting there is no special goal or direction. This can be a disturbing thought to the individual who looks upon relationship in terms of purpose or motive. While having a goal may give security, it can also blind one from the unexpected and the fresh, from original insights and resources for self-growth. Goal directedness is often a substitute for self-directiveness. That is why when one reaches a goal, the individual often experiences incompleteness and despair, the depression of not being a person, not fulfilling oneself and one's self-responsibility. The striving for a goal is often a direct act of self-denial. Kierkegaard describes the despair of self-denial in his book, *The Sickness Unto Death* (2, 342-344), as follows:

"A despairing man is in despair over *something.* So it seems for an instant, but only for an instant; that same instant the true despair manifests itself, or despair manifests itself in its true character. For in the fact that he despaired of *something,* he really despaired of himself, and now would be rid of himself. Thus when the ambitious man whose watchword was 'Either Caesar or nothing' does not become Caesar, he is in despair thereat. But this signifies something else, namely, that precisely because he did not become Caesar he now cannot endure to be himself. . . . In a profounder sense it is not the fact that he did not become Caesar which is intolerable to him, but the self which did not become Caesar is the thing that is intolerable; or, more correctly, what is intolerable to him is that he cannot get rid of himself. . . . Essentially he is equally in despair in either case, for he does not possess himself, he is not himself. . . .

"This is the situation in despair. And however thoroughly it eludes the attention of the despairer, and however thoroughly the despairer may succeed (as in the case of that kind of despair which is characterized by unawareness of being in despair) in losing himself entirely, and losing himself in such a way that it is not noticed in the least — eternity nevertheless will make it manifest that his situation was despair, and it will so nail him to himself that the torment nevertheless remains that he cannot get rid of himself, and it becomes manifest that he was deluded in thinking that he succeeded. And thus it is eternity must act, because to have a self, to be a self, is the greatest concession made to man, but at the same time it is eternity's demand upon him."

### *The Human Experience*

THE human experience I am presenting is one of real persons without specific goals, in which each person expresses himself not within a prescribed role, or as an expert, not in accordance with rules and conventions, but as a person with unified skills and talents who lives wholly and within the requirements of each unique, personal relationship. The result of such a relation may be an enlightened and open teacher or the return to health of an emotionally sick person, but this is incidental. Such change is the natural outcome of important human experiences. However, it is not something to be sought for but something which happens.

We feel that we must do something in order to influence the behavior of another person. We do not trust ourselves or believe that the organic unity of human nature and its potentialities are enough. We often resort to the skills of diagnosis and evaluation deliberately to find the weaknesses and inadequacies, the abnormalities and deviations of others. We sometimes think that through analysis and fragmentation we can put the pieces together. Yet we all know that a life being lived is a whole life. It begins and persists in wholeness. The creative relationship is unified and contains the resources for unique self-growth.

### *Love and the Absence of Evil*

THE life being lived always involves substantial, enduring relationships, in which persons create themselves, in which every expression honors human life and is responsible to it. Yet within the current social scene there is much emphasis on study, abstraction, analysis and diagnosis, and little regard for human life based wholly on a relationship of love and trust.

Kierkegaard has discussed the danger of a diagnostic approach and the way of love in human relationships. The following quotations are from his book, *Works of Love* (2, p. 310-312):

"And now the lover! For whether the world laughs at him, whether it ridicules him, whether it pities him, or whatever the world says about him, it is certain that concerning the multitude of sins, he discovers nothing, not even this laughter, this ridicule, this pity; he discovers nothing, and he sees but very little. He discovers nothing; we here make a difference between discovering as a conscious act, as a deliberate attempt to find out something, and the involuntary seeing or hearing something. He discovers nothing. And yet, whether one laughs at him or not . . . fundamentally one has an inward respect for him. . . .

"The lover discovers nothing, hence he conceals the multitude of sins which would be exposed through the discovery. . . . That which the world really admires as shrewdness is an understanding of evil; wis-

dom is essentially the understanding of the good . . . the understanding of evil (however much it wishes to delude itself and others into thinking that it can preserve its purity, that it has a pure understanding of evil) is still in *understanding* with the evil; if this understanding did not exist, if the intelligent man did not take pleasure in understanding it, then he would abominate the understanding of it, would prefer not to understand it. Even if this sense of evil indicates nothing else, it is still a dangerous curiosity about evil; . . .

"We all know that orientals honor a demented person, but this lover, who is worthy of honor, is, as it were, a demented person. We all know that in the old times they made, and rightly, a great distinction between the two kinds of madness: one was a distressing sickness, and one bemoaned such a misfortune; the other was called a divine madness. If we may for once be excused for using the pagan word "divine," it is a divine kind of madness lovingly not to be able to see the evil which lies just in front of one. Truly it is necessary in these clever times which have so much understanding of evil that we should make some effort to learn to honor this madness; for unfortunately it is all too frequent in these times that such a lover, who has a great understanding of the good but does not wish to understand the evil, is looked upon as a madman."

### *Being*

THE creative human relationship is a matter of being fully present as a person, not a matter of diagnosis, strategy, manipulation, and direction. Sometimes it means *being there* in such a way that the other person gains courage and strength to take steps on his own. A famous passage from Plato's Seventh Letter emphasizes this point: "After much converse about the matter itself and a life lived together, suddenly a light as it were, is kindled in one soul by a flame that leaps to it from another, and thereafter sustains itself. . . ."

It is truly a matter of touching something within the person, bringing into activity a potential already present, or an actuality temporarily blocked or stifled. It means freeing the other person to return or recover his own nature, enabling the other person to express himself, and his capacities. Every act of helping another to fulfill his unique potentialities is at the same time an actualization of one's own capacity for self-growth. It is an expression of being able to be, for this means being able to meet the person as a person and to value him as he is.

Being is the boundary and structure of individual life. For a person to be, there is one basic requirement, that the individual be true to himself. Only in true expression of one's own being can growth occur. Thus being is an essential condition to growth or becoming.

Being is the experience of self and other as a totality, as a whole, in the immediate presence. In the being experience there is no sense of time or direction, or separation of self from other. There is a complete absorption, self-involvement, and fullness. One cannot plan to be. One can only plan to be about to be. An experience of being is spontaneous and simply happens, or grows within significant personal situations. Only when one does not plan to listen to learn is one fully open to experience. Listening to learn may lead to partial and temporary achievements but full presence of being includes listening and enables the individual to develop in every way he can.

In her childhood, Mrs. Lawrence, a fifth grade teacher, was permitted to listen to music only for certain definite purposes. Her musical experiences were controlled by her parents. They selected the instruments she was required to learn to play. They took her to concerts and symphonies they felt would contribute to her knowledge and skill, and urged her to listen for variations in theme, tone and pitch. She was not permitted to listen to music on the radio or on records as this was felt to be a second-hand approach. They wanted her to have only the authentic experience of fresh music. In spite of all the special experiences they arranged for her, Mrs. Lawrence was unable to distinguish differences in tone. She deceived her parents and teachers because she could play mechanically with superior skill. Then, in college, for the first time she had an opportunity to be alone and to listen to symphonies on her own and in her own room. She was able to hear music all the way through without implicit questioning, without purpose in listening, knowledge to be gleaned or answers to prepare. It was sometime later, in a situation requiring Mrs. Lawrence to recognize variations in tone and pitch that she realized that she actually could feel these differences. Then she knew that through the being experience in music, she had learned to distinguish differences in sound, not mechanically and out of abstract knowledge, but in actually feeling and experiencing these variations.

### *The Requirements of Self-Experience and Inner Conviction*

HOW does one know if he is truly himself, if he is growing in terms of his unique potentialities, if he is expressing the organic requirements of his special human resources? I do not believe there is any way of objectively knowing, that is, any external evidence, but only a subjective, inner experience of substance and conviction. A letter written by the poet Rilke (3, p. 17-22) in answer to a young writer who sought his advice, beautifully expresses the validity of the inner conviction. I present it below, with some omissions.

Paris, February 17th, 1903

My Dear Sir:

Your letter only reached me a few days ago. I want to thank you for its great and kind confidence. I can

hardly do more. I cannot go into the nature of your verses; for all critical intention is too far from me. With nothing can one approach a work of art so little as with critical words: they always come down to more or less happy misunderstandings. Things are not all so comprehensible and expressible as one would mostly have us believe; most events are inexpressible, taking place in a realm which no word has ever entered, and more inexpressible than all else are works of art, mysterious existences, the life of which, while ours passes away, endures. . . .

You ask whether your verses are good. You ask me. You have asked others before. You send them to magazines. You compare them with other poems, and you are disturbed when certain editors reject your efforts. Now (since you have allowed me to advise you) I beg you to give up all that. You are looking outward, and that above all you should not do now. Nobody can counsel and help you, nobody. There is only one single way. Go into yourself. Search for the reason that bids you write; find out whether it is spreading out its roots in the deepest places of your heart, acknowledge to yourself whether you would have to die if it were denied you to write. This above all—ask yourself in the stillest hour of your night: *must* I write? Delve into yourself for a deep answer. And if this should be affirmative, if you may meet this earnest question with a strong and simple "I *must,*" then build your life according to this necessity; your life even into its most indifferent and slightest hour must be a sign of this urge and a testimony to it. Then draw near to Nature. Then try, like some first human being, to say what you see and experience and love and lose. Do not write love-poems; avoid at first those forms that are too facile and commonplace; they are the most difficult, for it takes a great, fully matured power to give something of your own where good and even excellent traditions come to mind in quantity. Therefore save yourself from these general themes and seek those which your own everyday life offers you; describe your sorrows and desires, passing thoughts and the belief in some sort of beauty—describe all these with loving, quiet, humble sincerity, and use, to express yourself, the things in your environment, the images from your dreams, and the objects of your memory. If your daily life seems poor, do not blame it; blame yourself, tell yourself that you are not poet enough to call forth its riches; for to the creator there is no poverty and no poor indifferent place. . . . And if out of this turning inward, out of this absorption into your own world *verses* come, then it will not occur to you to ask anyone whether they are good *verses*. Nor will you try to interest magazines in your poems: for you will see in them your fond natural possession, a fragment and a voice of your life. A work of art is good if it has sprung from necessity. In this nature of its origin lies the judgment of it: there is no other. Therefore, my dear sir, I know no advice for you save this: to go into yourself and test the deeps in which your life takes rise; at its source you will find the answer to the question whether you *must* create. Accept it, just as it sounds, without inquiring into it. Perhaps it will turn out that you are called to be an artist. Then take that destiny upon yourself and bear it, its burden and its greatness, without ever asking what recompense might come from outside. For the creator must be a world for himself and find everything in himself and in Nature to whom he has attached himself.

But perhaps after this descent into yourself and into your inner solitude you will have to give up becoming a poet; . . . But even then this inward searching which I ask of you will not have been in vain. Your life will in any case find its own ways thence, and that they may be good, rich and wide I wish you more than I can say. . . .

Yours faithfully and with all sympathy,

Rainer Maria Rilke

### *Concluding Comment*

IN the creative human relationship there is a feeling that reaches beyond the limits of self-awareness and into the heart of another person. There is a feeling of oneness, a feeling of communion. There is the freedom of being which enables each person to be spontaneous and responsible.

This freedom means opening oneself to a relationship, perceiving it as positive and unique. It means being there fully with all of one's special professional preparation and personal experience but allowing whatever will happen to happen, not forcing the direction or the results, but expressing one's talents and skills immediately, spontaneously, and in accordance with the unique requirements of each human situation.

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# MAN'S MATHEMATICAL MIND*

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## Instinctive Mathematics: the Enigma of Pre-Algebraic Computation

MUCH of today's anthropology, psychology, and history is based on the tacit assumption that eras of comparable level of civilization, even if thousands of years apart, were peopled by human beings who thought, felt and acted in similar ways. This is a viewpoint which tries to understand Babylonians in terms of modern psychology, to regard Homer as another Shakespeare who just happened to be born earlier. It reflects the belief that not only man's anatomy, but also his mind have remained substantially unchanged during the past 5,000 or 10,000 years.

This viewpoint is opposed by those who maintain that the very consciousness of man, the manner in which he experiences his environment and himself, undergoes an evolutionary change which is discernible even within historical periods; a change which deeply affects cultural evolution, but does not necessarily run parallel with it. One cannot do justice to the achievements of the past, one cannot even properly understand documents of ancient history, if one starts from the postulate that the people to whom and of whom these documents speak, while not quite as clever as we, still thought and experienced the world in essentially the same manner as we do.

The fallacy of such a postulate shows itself in every sphere of human activity of which records have survived to our day—in the sphere of art, for example, or of literature, or of religion. It is my purpose here to focus attention on the field of mathematics, [based upon] historically documented achievements.

ABOUT 4200 years ago, the Chinese Emperor Yau exiled two brothers named Hi and Ho, both court astronomers, because of the occurrence of an eclipse which they had failed to predict![1] Only an astronomer will fully appreciate what this event signifies: total solar eclipses are the result of the simultaneous occurrence of several component causes, and consequently occur, at any one geographic location, in an extremely complicated time pattern. Without the benefit of understanding the individual causes, it is a great feat indeed to "get the feel" of the time pattern observed in the past to the extent of permitting a reliable extrapolation into the future; and the punishment implies that reliable prediction had been the rule rather than the exception.

At the same time, some 5,000 miles to the West, the Near East also left evidence of a remarkable civilization. Especially in Mesopotamia, archaeologists in the last 70 years have excavated thousands upon thousands of clay tablets dating from about 3000 B.C. to 1200 B.C., whose cuneiform inscriptions have given, and continue to give, surprising insights into the minds of people barely past the neolithic age. They also give some insight into the very origin of mathematics.

It has long been thought, and is still widely held, that every cultural advance has been stimulated by practical reasons and purposes, by self-interest of a personal or social nature. Mathematics in particular is said to have had its beginnings in mental activities for the benefit of herdsmen and the enrichment of traders, for counting and accounting; and that it is only after the great uphill pull to our present level of culture that we may define mathematics as man's supreme bid for finding *within* himself a secure foundation for a gradual understanding of the world *without*.

Many of the Sumerian and Babylonian clay tablets seem to confirm this notion; some are just rows of numbers without annotation; others have indications which have permitted tentative identification as bills, receipts, notes, accounts, and systems of measures.[2] Once this had been established, all were thrown together under the head "Commercial Tablets" . . . un-

* Abstracted, with permission, from the Summer 1956 *Proceedings* of The Myrin Institute, Inc., at Adelphi College.

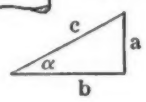
[1] R. Wolf, *Geschichte der Astronomie*, p. 9, (Munich 1877)
[2] David E. Smith, *History of Mathematics*, Vol. I, p. 37.

til, rather recently, someone thought of assigning mathematicians to the aid of archaeologists in the study of some of the more doubtful texts.

THE results of these studies will be illustrated by taking as an example one tablet which has won a degree of fame within the last ten years: the "Plimpton Tablet No. 322."[3] It contains nothing but four columns of numbers, written in the Babylonian sexagesimal notation (base sixty as we use base ten), and in a script which dates the tablet well before 1600 B.C. Translated into our decimal notation, the first few lines of the tablet are given below:

| $\frac{c^2}{a^2}$ | b | c | | a | $\alpha$ |
|---|---|---|---|---|---|
| Text of Tablet[4] | | | | Computed | |
| *1.9835* | *119* | *169* | *1* | 120 | 45.2° |
| *1.492* | *3,367* | *4,825* | *2* | 3,456 | 45.7° |
| *1.9189* | *4,601* | *6,649* | *3* | 4,800 | 46.2° |
| *1.8863* | *12,709* | *18,541* | *4* | 13,500 | 46.8° |

$$a = \sqrt{c^2 - b^2}$$




The first (right-most) column is obviously just a line numbering. It runs from 1 to 15. The second and third column, however, contained a real surprise: they were recognized as pairs of numbers belonging to "Pythagorean Triplets," that is, to sets of three whole numbers (a, b, and c) which fulfill the relation $a^2 + b^2 = c^2$. For example, in line 2, we can find a whole number (namely 3,456) so that $4{,}825^2 = 3{,}367^2 + 3{,}456^2$. The tablet contains only the two numbers 4,825 ("c") and 3,367 ("b"); the third number ("a"), not on the tablet, is shown in the above diagram to the right of the tablet text.

Not with every pair of whole numbers is the third number, "a", defined by the above relationship, a whole number; on the contrary, most pairs "c" and "b" will give an "a" = $\sqrt{c^2 - b^2}$ which is not at all an integer, but a so-called "irrational quantity"; that is, the square root of a number which is not the square of an integer. Only comparatively few pairs of integers permit of a "Pythagorean Triplet"; some of the smallest of these pairs are 5 and 3, 13 and 5, 17 and 15, 25 and 7. To have found a few of these pairs would have been a creditable achievement for ancient mathematics. To realize, centuries before Moses, that 18,541 and 12,709 are such a pair, is a feat that leaves modern man open-mouthed.

[3] Plimpton Library of Columbia University, New York, N. Y.
[4] According to *Mathematical Cuneiform Texts* by O. Neugebauer and A. Sachs, American Oriental Series, Vol. 29, New Haven, 1945, as quoted in *Number Theory and its History* by Oystein Ore, New York, 1948.

There is, of course, not the faintest possibility of such results being found by trial and error: each of the fifteen lines of the Plimpton Tablet contains such a pair, and eight of them list numbers whose squares run into many millions. Hence we cannot but conclude that among those ancient Mesopotamians there were men who had clearly before their mind's eye a respectable portion of what we call today "theory of numbers." Yet, how could they realize and mentally sustain a rather complex body of theory without the use of algebra? And there can be little doubt that algebra was unknown in pre-Christian times; all mathematical documents found so far have in common the complete absence of any algebraic symbol. Where they want to make a point, they do so by presenting, almost always without comment, one or several numerical examples.

This, too, is very significant: we cannot simply attribute it to a lack of mental capacity for generalization; people who handle Pythagorean Triplets of large numbers with such facility must be credited with the ability of expressing, in some manner, a general rule they know so well. If they never do, there must be some good reason for it. We could conjecture on two: either they *did not want* the general relationships to become known; or there was *no need* to express them in abstract form. This latter, however, would mean that, to the people of that age, numerical *examples* conveyed some sort of an immediate "perception" of the relationships that exist between numbers.

I have a vivid recollection from way back when, as a teenager, I saw a man who toured Vienna's senior high schools with demonstrations of baffling arithmetical wizardry: he would ask to be given a couple of numbers five to ten decimal-digits long, and would dictate, within a few seconds, the cube root of their product, accurate to ten places, and similar incredible feats. It took us, and our teachers, days to check all his answers; but right they were, all of them. When asked how he knew, the man was visibly uneasy; all he would tell us was that, in a slightly dream-like state which he could produce at will, he experienced numbers as realities which he could manipulate like a sculptor kneading and forming his clay. This explanation certainly did not help us in the least to acquire a similar facility with numbers; for what he intimated is something that just does not exist within the realm of the average modern man's conscious experiences. —Yet we had seen the facts; and they spoke a stirring language.

This boyhood experience comes to my mind when I think of the Plimpton Tablet; think of the almost arrogant nonchalance with which only two of the three numbers of each Pythagorean Triplet are listed: a fact that implies complete familiarity with the theory of integer triplets, as well as with the techniques of squaring and computing square-roots of large num-

bers. To be sure, many of us can easily follow this theory, and some of us can even recreate this or other sections of number theory of equivalent complexity. But in doing so we work with abstractions, link them by formal logic, and preserve the result of every short step by, so-to-speak, "pickling" it in algebraic symbols, and "canning" it in a formula; only so can we maintain our continuity of thought. (And, incidentally, our mathematics-teaching is unfortunately all too often mere instruction in the use of can openers!) The Babylonians of 4,000 years ago, on the other hand, knew these same relations without algebra. This suggests the thought that at least some of them, priests or sages, had the faculty of experiencing mathematical relationships in a more direct, in a living way: "perceiving" or "recreating" them whenever they directed their mind's eye on them. . . .

WHAT has been considered so far is, however, only a part of the mathematical insight hidden in that remarkable tablet. In a geometrical interpretation, the second and third columns represent the hypotenuse and one leg of a right triangle of such nature that all three sides measure in whole numbers; this according to the famous theorem named after the Greek philosopher, Pythagoras, whom the unknown Babylonian scribe antedates by as much as Charlemagne antedates us!

Such a geometrical interpretation supplies the key to the question why some of the lines contain large numbers, some rather small ones. Each right triangle defines a certain angle, for example the one opposite the unlisted side "a"; and if these angles are computed and listed, as has been done above to the right of the tablet text, it appears that successive lines correspond to angles which increase in fairly regular steps from 45 to 58 degrees: this amazing tablet, close to 4,000 years old, turns out to be nothing less than part of a trigonometric table in implicit presentation! One trigonometric function, namely $c^2/a^2$, or "cosecant-square" as we would call it, is even explicitly listed in the tablet's last (left-most) column.

Yet even this is not all: our decimal-translation gives the last column to five places; actually it would need an unending sequence of decimal digits. In the original sexagesimal notation, on the other hand, these numbers are comparatively short and simple, as 7/4 or 13/8 are in decimal notation. This indicates familiarity with what we call the theory of decimal expansion. This, then, is the reason for the apparent randomness in the sequence of small and large numbers; it is necessary to fulfill the triple purpose which the author of the table had in mind: to list right triangles whose sides are whole numbers, whose angles increase in regular steps, and whose precise cosecant needs only few numbers in sexagesimal notation. Thus the Plimpton Tablet 322 proves familiarity, 4,000 years ago, with

the arithmetic of squares and square roots of large numbers,
the geometry of right triangles,
the number theory of Pythagorean Triplets,
the elements of trigonometry, and
the number theory of sexagesimal expansion,

and all this without algebra.

Where are those Babylonians today? Geophysical changes, military conquest, and other causes made them fall by the wayside, as did their neighbors in Egypt. But before they did, they handed the torch of their wisdom to Greece, which we ordinarily consider the cradle of our culture.

## Research in Creativity

THE problem of education and of teacher training is approached from a fresh point of view by Viktor Lowenfeld, Head of the Department of Art Education at Pennsylvania State University, in a paper entitled "Art for Teacher Education in This Time of Stress." The address was presented at the annual meeting of the American Association of Colleges for Teacher Education in February 1958, and will be published in the *Yearbook* of the Association.

Prof. Lowenfeld presents his discussion of our present educational methodology and its requirements against a background which sees education in its broadest aspects, as responsible for our attitudes and actions, as well as for scientific achievements and social institutions. He cites the fact that progressive educators are most often satisfied to house their efforts in buildings whose architecture is Gothic, colonial or Georgian, thus displaying "their lack of confidence in their own message." "Gothic" churches are dwarfed by skyscrapers while television sets are built in period-style cabinets. Such evidence of disunity between art and society symbolizes our present-day confusion.

In considering the serious misunderstandings of the role of education in our society, Lowenfeld emphasizes that scientific progress cannot be separated from education in general. In our educational system, "most everything still points toward that phase of learning, which in most instances means accumulating knowledge." Yet this kind of emphasis neglects those attributes of growth which are responsible for the development of the individual's sensibilities, his broadening cultural and spiritual qualities, and his creative potentialities. "In a well-balanced educational system in which the development of the total individual is stressed, his thinking, feeling, and perceiving must be equally developed in order that the potential creative abilities of each individual can unfold."

Neglect of this vital need of creativity has two causes: First, ignorance of its meaning and criteria, and hence inability to incorporate it into a new methodology. Second, the fact that creativity has been thought to be mainly the domain of the arts.

For the last seven years the Department of Art Education of Pennsylvania State University, with Kenneth Beittel, Lambert Brittain and Viktor Lowenfeld as main investigators, has been doing research on creativity, in an effort to find criteria "which may significantly differentiate between creative and less or non-creative people in the arts." The object of this research was to find means which could more effectively promote creativeness, especially on the adolescent or post-adolescent level. Similar studies were conducted independently by Dr. J. P. Guilford at the University of Southern California, to find measurable criteria responsible for creativeness, this time in the sciences. Significantly, these two independent studies arrived at almost exactly the same criteria, thus establishing that creativeness in the arts as well as in the sciences has common attributes. The eight attributes are as follows:

1. *Sensitivity to Problems* — Since creative work must be based on a sensitive experience, the promotion of sensitivity is a vital part of all education. Sensitivity is defined by Guilford as "seeing defects, needs, deficiencies, or seeing the odd, or the unusual." To this Lowenfeld adds sensitivity to materials and media. Sensitivity to problems implies the ability to identify with them; through this, to appreciate art and also to appreciate others.

2. *Fluency of Ideas*—Fluency may be ideational or associational, and the latter may be sensory or verbal. Basic to any teaching should be the promotion of greater fluency both in the choice of experience and in the use of material.

3. *Flexibility*—Under this term is understood the individual's capacity to adapt or adjust quickly to new situations.

4. *Originality*—This is a vital part in the distinction between creative and non-creative people. It is indicated by uncommonness of responses, both verbal and sensory. Nonconformity is implicit in such "uncommonness," and therefore education must in certain instances foster it.

5. *Redefinition and the Ability to Rearrange* — Guilford refers to this as the ability to shift the function of objects and use them in a new way; also as the "Gestalt transformation." This ability to use the mind to find new meanings and purposes is an important attribute of any creative process.

6. *Analysis, or the Ability to Abstract* — In any creation, it is necessary to abstract from generalities and arrive at specific relationships. Analysis penetrates the nature of an experience and discovers its individual details.

7. *Synthesis and Closure*—The ability to combine several known or given elements to form a new whole is synthesis.

8. *Coherence of Organization*—This part of creativity is most closely related to aesthetics, for aesthetic growth appears to be responsible for the changes from chaos to the most complete harmonious organization. Aesthetic organization is organic, and is intrinsic to individual work, whatever it may be. Lowenfeld states

that "this criterion of creativity appears to be an essential part not only of aesthetic education but of any liberal education in which man learns to bring his thinking, feeling, and perceiving in harmonious relationship to himself."

In our present curricula, art appears to be the main promoter of creativity. But since creativity cuts across disciplines, its promotion in the arts may ultimately be responsible for more creativeness in the sciences and elsewhere. It is Lowenfeld's hope that his researches "may be of some help in the formulation of a new methodology in which creative teaching will be an integral part of the teaching of any subject matter," and thus create in education a spirit which will help man to "discover himself and his own potential creative ability out of his own urge to break through boundaries in his search for the unknown."

—*E. B. Sellon*

## Frictionless Order

K. Mendelssohn has an article in the January 31, 1958 issue of *Science* entitled "Superfluids," and in the November 1957 issue of *Scientific American* there is a paper entitled "Superconductivity" by B. T. Matthias. These two physicists have brought to our attention some of the strange phenomena which have resulted from the effort to approach absolute zero.

Dr. Mendelssohn states that, "Absolute zero, as such, is a rather old concept. Two hundred and fifty years ago Amontons had already visualized some state of matter at which all motion would come to rest, and which thereby would constitute a lower limit to our temperature scale. The concept of the ultimate cessation of molecular motion was maintained in this form for quite some time, until 50 years ago, when Nernst, by enunciating the third law of thermodynamics, somewhat modified it by substituting for the zero point of energy the zero point of entropy.

"Entropy is a concept which many people consider 'difficult.' Even scientists dislike it sometimes, but, after all, it is not such an abstract thing. It simply measures the degree of disorder in any physical system."

Low temperature research is now more concerned with "ultimate order rather than ultimate rest in matter." It is, as a matter of fact, now established that even at a temperature of absolute zero there is a certain irreducible minimum of atomic motion.

Investigations into some of the properties manifested by materials at temperatures which approach absolute zero have given results which "have no counterpart in the observational world of everyday physics. It has been discovered that certain materials, such as lead, for example, when reduced in temperature to within a few degrees of absolute zero exhibit the property of superconductivity. "If you take a closed ring of . . . lead and induce a current in it, then this current will run . . . as long as the ring is kept in liquid helium. Recently it has been shown that the current will run for years without any decrease in its strength. . . . In a Dewar vessel containing liquid helium, such a current was induced in a set of rings, and a lead sphere was dropped into the system of rings. As the sphere approached the rings, the persistent currents in the rings induced a system of persistent currents on the surface of the sphere. These currents being mutually repellent, the sphere was slowed down in its fall until it came to rest at a position where the mutual repulsion of the currents just counterbalanced the weight of the sphere. There it hung suspended in space by this unusual and strange phenomenon."

Experiments with helium which remains in a liquid state at near absolute zero temperature, disclosed that it "flows through quite narrow channels at a very high rate and largely independent of pressure." In other words, we have the unique phenomenon of the flow of a liquid without resistance. This is called superfluidity.

Dr. Mendelssohn states that the lack of resistance to a current of electricity associated with some materials at low temperatures has been known for nearly a half century and there have been numerous attempts to explain it without much success. "This is not due to the fact that we know so little about superconductivity; actually, the trouble is that we know rather too much."

Dr. Matthias in his paper states that "the unimpeded movement of electrons (electric current) through a superconducting metal is analagous to the unimpeded motion of electrons around the nucleus of an atom" and at the other end of the scale of material phenomenon there is the unimpeded motion of the planets around the sun.

Dr. Mendelssohn points out that these phenomena of superfluidity and superconductivity are concerned with widely separated physical systems and so must reflect something very fundamental in nature. He then goes on to consider some theoretical possibilities about the nature of these atypical phenomena and speculates that perhaps "the frictionless state of aggregation is the common form of aggregate matter in the universe and that the solid state is a rather strange oddity reserved for our own odd corner of the universe."

Perhaps the most thought-provoking aspect of these papers is the fact that order, possibly of position but more probably of momenta, is associated with the lack of friction or superfluidity and superconductivity in certain materials. Ordinarily the physicist works with matter characterized by varying degrees of entropy. But when, as in these low temperature experiments, entropy approaches zero, unprecedented qualities become manifested.

Could it be that this order pattern which Dr. Mendelssohn assumes from the data to be "of a very fundamental nature" is effective at higher organizational levels such as we encounter in living materials?

—*Alfred Taylor*

## A Bipolar Approach to Religious Symbolism

THE Winter (1957-58) issue of *The Antioch Review* contains an article entitled: "Ethos, World-view, and the Analysis of Sacred Symbols." The author, Clifford Geertz, holds a Ph.D. in anthropology from Harvard University, and spent several years in Indonesia as a member of a research team. At the present writing, he is again in Indonesia.

In recent anthropological discussion, the moral and aesthetic aspects of a given culture, the *evaluative* elements, are summed up in the term "ethos," while the *cognitive* aspects are designated "world-view." A people's ethos is the tone, character and quality, the style and mood of their life; their underlying attitude towards themselves and their world. Their world-view is their picture of the way things actually are; their concept of nature, of self, and of society. Dr. Geertz uses these two terms, not in a contrasting sense, but rather as a complementary, bipolar approach to the understanding of religious symbols, examining both icon and ritual. The following excerpts, necessarily abbreviated, point up his main arguments.

"Religion is never merely metaphysics. For all peoples the forms, vehicles, and objects of worship are suffused wih an aura of deep moral seriousness. The holy bears within it everywhere a sense of intrinsic obligation: it not only encourages devotion, it demands it; it not only induces intellectual assent, it enforces emotional commitment. . . . Never merely metaphysics, religion is never merely ethics either. The source of its moral validity is conceived to lie in the fidelity with which it expresses the fundamental nature of reality. The powerfully coercive 'ought' is felt to grow out of a comprehensive factual 'is,' and in such a way religion grounds the most specific requirements of human action in the most general contexts of human existence. . . . This demonstration of a meaningful relation between the values a people holds and the general order of existence within which it finds itself is an essential element in all religions. . . . Whatever else religion may be, it is in part an attempt . . . to conserve the fund of general meanings in terms of which each individual interprets his experience and organizes his conduct. . . ."

In Java, where the author has done much field work, individuals who ignore the moral-aesthetic norms, are regarded not as evil so much as stupid, insensitive, unlearned, or even mad. Unethical behavior is referred to as "uncustomary"; the more serious crimes are commonly accounted for as an assumed lapse of reason, the less serious ones by a comment that the culprit "does not know order," and the word for "religion" and for "science" is the same. Morality thus has an air of simple realism, of practical wisdom; religion supports proper conduct by picturing a world in which such conduct is only common sense. Dr. Geertz gives profuse illustrative examples of the working out of this concept, from his personal observations in Indonesia. One such example follows:

"It is only common sense because between ethos and world-view, between the approved style of life and the assumed structure of reality, there is conceived to be a simple and fundamental congruence such that they complete one another and lend one another meaning. In Java, for example, this view is summed up in the concept one hears continually invoked, that of *tjotjog*. *Tjotjog* means to fit, as a key does in a lock, as an efficacious medicine does to a disease, as a solution does to an arithmetic problem. . . . If your opinion agrees with mine we *tjotjog;* if the meaning of my name fits my character . . . it is said to be *tjotjog*. Tasty food, correct theories, good manners, comfortable surroundings, gratifying outcomes are all *tjotjog*. In the broadest and most abstract sense, two items *tjotjog* when their coincidence forms a coherent pattern which gives to each a significance and a value it does not in itself have. There is implied here a contrapuntal view of the universe in which that which is important is what natural relationship the separate elements have to one another, how they must be arranged to strike a chord and to avoid a dissonance. And, as in harmony the ultimately correct relationships are fixed, determinate, and knowable, so religion, like harmony, is ultimately a kind of practical science, producing value out of fact as music is produced out of sound. In its specificity, *tjotjog* is a peculiarly Javanese idea, but the notion that life takes on its true import when human actions are tuned to cosmic conditions is widespread. . . . What all sacred symbols assert is that the good for man is to live realistically; where they differ is in the vision of reality they construct. . . .

"The view of man as a symbolizing, conceptualizing, meaning-seeking animal . . . opens up a whole new approach not only to the analysis of religion as such, but to the understanding of the relations between religion and values. The drive to make sense out of experience, to give it form and order, is evidently as real and as pressing as the more familiar biological needs. . . .

"An approach to a theory of value which looks toward the behavior of actual people in actual societies living in terms of actual cultures for both its stimulus and validation will turn us away from the abstract and rather scholastic arguments . . . to a process of ever-increasing insight in both what values are and

how they work." Dr. Geertz feels that the role of such a special science as anthropology in the analysis of values is not to replace philosophical investigation, but to make it relevant.

—*Alan Mannion*

## Consciousness as a Mathematical Function

THE concepts of space, time and consciousness obviously present problems to those who, within our common-sense or "normal" frame of reference, seek to understand such phenomena as precognition. Less obvious, but equally important, is the fact that only by serious attention to these concepts can material advances be made in understanding cognition, consciousness, and other aspects of the mind.

It is difficult to compress the many concepts introduced into the paper written for the December 1957 issue of the *Journal of Parapsychology* by J. M. J. Kooy, professor of theoretical physics and theoretical mechanics at the Royal Military Academy in Breda, Holland. Discussing "Space, Time and Consciousness," the author points out that "our common conceptions of space and time are completely useless (in relation to precognition) . . . a man's consciousness at any moment has to be regarded as a function (in the mathematical sense of the word) of the simultaneous, instantaneous state of the brain."

Restating the concepts of the nature of the multidimensional, space-time continua of modern physical mathematics, the reader is reminded that "In a space-time world . . . it is only possible to speak of a *state of being.*" With such concepts in focus, what, then, is the brain? What is its function? And what of perception?

"The brain," Dr. Kooy says, "although part of a living organism, is nevertheless a material object, so that from a wider point of view we may regard it as a four-dimensional brain sub-stratum, not only extending in space but also in time . . . to be considered identical with all events constituting the whole life of the brain from birth to death. . . . This means that the old view that a man's consciousness is a function of the instantaneous brain state has to be replaced by the broader view that *this consciousness is a function (in the mathematical sense) of the four-dimensional cerebral structure.* Hence this consciousness has *no time coordinate at all. . . .*"

To the objection that perception as experienced always and everywhere seems to be shot through with space and time, the author replies, ". . . the impression we have of a 'flow of time' and a corresponding shifting 'Absolute Now' must be immanent in our perceptions themselves. . . . It seems that any one perception has, with respect to all other perceptions the 'timbre' *now,* so that with respect to *any one* perception all other perceptions are past or future. . . . No perception has an absolute time coordinate . . . any one perception is linked with all other perceptions. . . ." This relates to the fact that "past" and "present" experience bear a degree of organization which "future" experience may not have. One of the functions of the brain may thus be to measure the *entropy gradient* in such a way that "from the space-time point of view we can only say that in connection with the cerebral substratum a certain statistical quantity expressing the degree of disorder varies. A part of this substratum, in which the disorder is larger than in another part, is perceived as 'the later brain state.' This impression of a 'flow of time,' *based on the structure of our brain substratum,* is projected by us into the external world."

Cause and effect can be entertained only where space and time are accepted as independent entities. "In the space-time world, in which past, present and future belong to the same level of reality, there can be no question of forces and reactions of forces but only of a being of events.

"It is, moreover, of great importance to realize that a 'body in itself' is a product of mere mind-spinning, not belonging to the real world of events, which is extended in space-time. What we call a 'body' is only a kind of permanence perceived by us in the 'course of events.' In a similar way, in quantum mechanics, an atom in a definite state of energy, or an electron by itself, must be considered only as a metaphor. . . . All these incongruities disappear as soon as 'matter' is replaced by 'action,' the basic material of becoming, of events.

"Looked at in a similar way, it will be clear that there cannot be an instantaneous brain, the physical base of instantaneous consciousness. Only *cerebral events* exist which may be the physiological counterpart of consciousness. . . . According to the conceptions advanced [the whole complex of memory] can be regarded as corresponding physiologically with: (1) cerebral events belonging to remembered past perceptions; and (2) cerebral events at the time of remembrance. . . . It depends on the subtle 'timbre' of the whole complex whether it includes a paranormal aspect, or whether it belongs to the range of what in psychical research is named the normal."

Demonstrations (including mathematical proofs in an appendix) of the means by which these conceptions may throw light upon precognition, phantasms, etc., are given. "The possibility of mental interdependences beyond time need not be limited to just two persons but may be increased to include an indefinite number. In this way it is in principle possible to account for collective apparitions."

The author concludes, "The study of such interdependence has been rather neglected up to the present on account of the traditional (but no longer tenable) philosophical viewpoint of the existence of a separate and independent space and time."

—*Harvey W. Culp*

# NEWS AND NOTES

THE present challenge to education and to thought about Americans mores generally has brought about what may be a remarkable advance in the Office of Education in the Department of Health, Education and Welfare. Dr. Roy M. Hall has been appointed Assistant Commissioner in charge of what is essentially research into knowledge, the knowing process (as such), the learning process (so much more general a term), and so on. The program will be watched and reported from time to time.

One hopeful aspect is the assignment of ultimate responsibility to research staff, and consultants. It is too early to say whether the inquiry will include needed studies in methodology. That meaning is to be analyzed and hypotheses tested indicates that certain scientific criteria will be applied. But it is well known that there are two complementary kinds of scientfic method, i.e. ways of knowing and arriving at generalizations and classes, both essential: (A) empiricism and hypothesis, prediction and test; and (B) postulation, structuring, deductive prediction and test. If the emphasis is upon A, the program will further exaggerate the present imbalance, and add to confusion. For A ends up necessarily in arbitrated opinion of the few for the many, a process unsuited to a democracy and dangerous if left uncorrected by any other procedure. B, however, displays the reasoning from beginning to end, educates in terms of natural orders and principles, and gives confidence in meaning and in man.

We look upon this new development with eagerness and the hope that it will clarify and not cloud the great issues at stake; that it will provide even the smallest beginnings of the American consensus.

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THE fascinating passages from Professor John Kreitner, Chairman of the Department of Mathematics at Adelphi College (published elsewhere in this issue), come from his contribution to the *Proceedings* of the Myrin Institute. At Adelphi, and at the Waldorf School of that College, a continuous program is being worked out, from kindergarten to the highest levels. This allows the entire spectrum of organized education to be studied and improved by what is, operatively, one faculty, albeit administration of college and school are independent of one another.

The article under question dramatizes the whole question of the nature of the human mind. Instinctive mathematics (as we may call it for want of a better term) has often been observed, posing this question among others: What goes on, deep in human nature, that some individuals can give immediate answers to problems which ordinarily involve great labor? How was it possible for very early civilizations to create such fundamentals as zero, place numeration, the decimal system, and quadratic equations? The mathematicians now have new occasion to call upon psychologists, historians, anthropologists. But still deeper lies the essential problem of how to circulate the knowledge that would challenge those who refuse to see that the divorcement of thought from feeling in contemporary education is quite as bad as was once the divorcement of thought from action.

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WHAT is probably the most thorough study of Technical Education in the U.S.S.R. will be found in the booklet with that title, by C. E. Simmonds, published by the London Society for Cultural Relations with the U.S.S.R., 1957, 2s.6d. A thorough analysis will be found in *Nature,* Feb. 1, 1958, page 316 et seq. Few reports in this country have done justice to the emphasis in the first ten years upon clear grasp of principles, especially those of science.

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HAROLD P. Fawcett, Professor of Education at Ohio State University, has been elected president of the National Council of Teachers of Mathematics, the largest of the associations of American mathematicians functioning especially in education. Currently, there is lively discussion about mathematics teaching in general, and about the teaching of young children in particular, since all edifices depend upon secure foundations. The recent visit of Miss Vina Pow demonstrated effectively that very young children can engage in mathematical exercises with ever-increasing zest. Teachers who observed her at work with the Cuisinaire materials realized that entirely new possibilities have opened up in mathematics teaching. In September, Dr. C. Gattegno will tour the country. He is President of the Association for Teaching Aids in Mathematics, Secretary of the International Commission for the Study and Improvement of the Teaching of Mathematics, and Co-Director of Laboratoire International pour L'Etude Experimentale du Dynamisme Humain. At a moment when creativity and research exchanges are proceeding throughout the world, and intense interest and new needs are appearing in this country, Dr. Gattegno's visit is most timely.

—*F. L. Kunz*

# REVIEWS

## The Ultimate Questions

THE significance of *Philosophy of Education,* by Philip Phenix of Teachers College, Columbia University, goes beyond its content, style and handsome format (Henry Holt, N. Y., 1958, 587 pp, bib., index, $5.75). The author majored in mathematical physics and teaches in the area devoted to Foundations of Philosophy. He discusses education in the school, in nature and society, the fields of knowledge, and ultimate questions in education. In the latter section, the chapter on the ultimate nature of things reviews metaphysics, substance and process, structure and function, things and events, object and field, essence and existence, ideal and actual, abstract and concrete, the one and the many, mind and matter, nature and supernature. These are stock questions which the reader would expect to have, if not resolved (say, in the subsequent chapter on the cosmic process), at least brought under some kind of methodological consistency. But this expectation is not realized. The universe is described as a hierarchy of ordered beings, and man is placed in the role of that being who can collaborate with the evolutionary order or not, as the individual may elect or may be forced to do. To have all this and much more assembled is a great gain for the young teacher. But here the argument rests, for the most part at the descriptive level.

There are innumerable opportunities to press it home. The magnetic field is briefly described; but this reader did not get from that passage any idea that the field is both non-material and real, nor any notion of causal interconnection. Yet it is alphabetical that force is required (that is, work is done) to set up the magnetic field, which implies that space (the continuum) has some kind of reality, and that in the case of open fields it must be a singular aspect indeed of reality. What an opening for new insight! Again, on page 367 a paragraph begins: "It is a great and illuminating idea that the world of natural science is only known statistically. This is connected with the primary fact that natural science is the study of the metric aspect of things. Measurement is necessarily statistical." What is said about deduction on page 338 does not correct the erroneous impression of these quoted words.

Professor Phenix has written a most readable, comprehensive and useful text for teachers. His training is scientific, and we gather that his bias is religious. There are innumerable explicit references to spirit, spirituality, religion, God, soul, and the like; he confronts the issues. Students will gain strength from the author's quiet assurance. Yet when there are so many golden opportunities all about us to begin the valid fusion of science and religion (in its vitally important, rational aspects), the thrust is often lacking. That both religion and science are based on faith in the constancy of the universe is not enough for today. The rich fabric of order in nature, the newly disclosed resources of man's mind to command those orders suggest that there may be both meaning and justice. It would take but little additional labor in a future edition of this book—which will be widely used for many good reasons—to pull the argument together.

The significance of this book goes beyond its contents, its agreeable manner, and its comprehensiveness. It raises once more the question about our leading institutions of higher learning. That there should be freedom is vital; but that there is not time for working out integrative principles is deplorable. For these disabilities no individual writer is responsible. Professor Phenix has spared us a remaking of the views of the celebrities in philosophy. He cites no one in his text. The bibliography shows his acquaintance with a great range of philosophers; but the books are not even keyed into the pages. His material is his own. But at the end we are delivered over to faith. The puzzles remain on the reader's hands. Perhaps the new studies to be directed by Dr. Hall in the Office of the Federal Commissioner of Education may begin the articulation of methodical principles for those concerned with the philosophy of education.

—*F. L. Kunz*

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## Cause of the Ice Ages

HAPGOOD'S theory of the shifting of the earth's crust, as embodied in his book, *Earth's Shifting Crust,* by Charles H. Hapgood with the collaboration of James H. Campbell (Pantheon Books, N. Y., 1958, $6.50), may become as famous as Darwin's theory of the origin of species or Einstein's theory of the expanding universe. Each one is deduced from available scientific facts under the assumption that the universe is governed by laws of physics such as magnetism, electricity, gravitation, and inertia of matter, the first and second laws of thermodynamics, conservation of angular momentum, and some biological principles, such as the randomness in the evolution theory or, in other words, the so-called "survival of the fittest." Given this set of scientific laws and principles the author is perfectly within the scientific limits to develop the theory of the shifting of the earth's crust.

Geology and geophysics together with paleontology made great progress with the development of new scientific methods for the dating of the earth's crust. The radiocarbon ($C_{14}$) method gives us a good tool to date with great accuracy as far back as 50,000 years, or the ionium method (based on the same principle) for the dating of the sea bottoms to even more remote pasts.

Hapgood claims to have found the correct explanation for the traces of ice ages throughout the globe from the polar regions to the equator alike. Previously, geologists and geophysicists attributed the occurrence of ice ages to overall lowering or raising of the earth's temperature in regular rhythmic manner about every 21,000 years. However, Hapgood contends now that

the ice ages occurred randomly and not in cycles, for there seems to be no reason to assume that the sun radiation has varied in this pulsating manner.

Hapgood goes into great detail in the study of the earth's crust and leads the reader through an assembled maze of data which the reviewer finds quite gratifying. Among other things it is worthwhile to mention a cataclysm which occurred all over the earth some 11,000 years ago. The Siberian tundra and islands show remains of tens of thousands of mammoth tusks all preserved in the permafrost as though the animals had died yesterday. The famous Beresovka mammoth, discovered in 1901, was so well preserved that wolves ate part of it before the members of the Russian Academy of Science had time to arrive from St. Petersburg. Upon analysis its stomach contents showed that the climate during its life was warm, comparable to the present-day climate of a region some 2000 miles farther south. The mammoth was overtaken by that catastrophe so quickly that it could not even finish the meal in its mouth. We can call Hapgood's deduction of the season of the year unique. He says that it must have happened in the months of July or August. The reviewer is familiar with Plato's version (*Timaeus* and *Kritias*) of this cataclysm and also with one given by Indian astrologers. According to the latter, it happened in the year 9564 B.C. when the sun was in the zodiacal sign of Cancer, that is, between June 21 and July 21. This is a remarkable coincidence of scientific deduction.

The freshest traces of ice ages at present are in Eurasia and North America, the so-called Scandinavian and Wisconsin glaciation, which receded some 10,000 years ago. Hapgood claims that the pole was in the Hudson Bay region at that time. He explains the migration of the poles by the shifting of earth's crust due to excess centrifugal force of unbalanced matter, and holds that it is due to the accumulation of ice in the ice caps, so that the isostatic condition of the crust is destroyed. The earth is composed of four distinct layers. The crust, or the lithosphere, floats on top of the second layer, the asthenosphere, or magma, which is uncrystalized basaltic rock in viscous fluid form due to high compression and temperature.

It is not assumed that the specific pressure of the crust at the bottom is uniform throughout the globe. This means that isostatic balance is not achieved. It means also that the average specific gravity of the crust is not constant, but varies within allowable limits of the crust tensile strength. It must be then assumed that the crust is in equilibrium for some time after a catastrophe, which is nothing else but equalizing of isostatic pressures. Hapgood claims that in case a continent lies across one of the poles, there begins accumulation of ice due to snow fall and no melting. The accumulation of ice constitutes an unbalanced dynamic force acting perpendicularly to the axis of rotation. It can be decomposed into a tangential and radial component with respect to the surface of the earth. While the radial component takes away from the gravitational constant and, therefore, is not different from any other part of the globe, the unbalanced tangential component exerts a pulling pressure on the crust like a belt on a pulley. As the accumulation continues, there comes a moment when the crust begins to slip with great convulsions, mountain forming, buckling and folding over of the crust, accompanied by great volcanic action and by partial subsidence of some of the continents. The reviewer is greatly simplifying the theory and has skipped some of the finer points. The author, with his collaborator, J. H. Campbell, computed from assumed masses the tangential pull and wedge-like pressure on the crust. They came out with figures of range for the forces which they believe to be within the limit of ± 50% correct. They computed the stress within the crust to be about 1700 lbs. per square inch at present. They believe that it is close to the breaking point again and that we may expect another cataclysm within the next 10,000 years.

In criticism of this theory, it is rather unfortunate that the authors omitted computation of the viscous drag between the crust and the asthenosphere. It could have been easily done by integration over the whole globe, taking into account the coefficient of viscosity, specific pressure at the bottom of the crust. By doing so they could have found out whether the centrifugal force of the ice cap was sufficient to overcome it.

Sometimes it is necessary to keep the ratios in one's mind in order to better understand what is going on. Let us then construct the model of the earth 5″ in diameter, or something like a large grapefruit. The thickness of the crust on such a model would be equal to 0.025″. Now imagine the formation of the ice cap at the pole in thickness of 0.0012″. One would have to use a good micrometer to be able to measure it. The center of gravity of the ice cap would be 0.22″ away from the axis of rotation. In order that comparable centrifugal effect should be exerted on this model, it would have to rotate at the rate of 7 revolutions per minute. Hapgood attacked the problem arithmetically rather than with the help of higher calculus algebraically. He could have integrated separately the tangential component and radial component over the whole globe and come out with certain qualitative conclusions. Let us say then that the radial component integrated over the whole globe did not equal to zero, which means that the earth is unbalanced and that there is exerted a one-sided pressure on the axis of rotation. The axis would start to wobble so far as the "assumed" axis of rotation is concerned. But since the earth is suspended in the gravitational field of the sun, it is free to change its axis of rotation, which is a well-known fact to balancing engineering experts. It is a law of physics that freely suspended bodies rotate on an axis going through the center of gravity with no unbalanced dynamic couples of forces present.

It has been thus proved theoretically that it is impossible for a freely suspended body to rotate on any other axis but the one which is free of unbalanced forces. The integration of the radial component over the whole globe must be equal to zero. And *eo ipso* the integration of the tangential component over the whole globe must be equal to zero identically. It has been proved so far that during a quiescent period of the earth, the occurrence of unbalanced forces on the crust is a mathematical and physical impossibility due to the automatic adjustment of the axis of rotation. The reviewer's argument is based on the assumption that the density of the asthenosphere is perfectly uniform throughout. Nevertheless the reviewer recommends warmly this book as very instructive reading and a plausible explanation of the ice ages.

*—Bohumir Larys*